Carbon Measurements at ARM-SGP for OCO Validation

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Outline

Overview of ARM Carbon Project

Carbon Measurements for OCO Validation

Initial Estimate of Column CO_2

Further Work

Goal of ARM Carbon project: Improve understanding of land-surface CO_2 climate forcing and ecosystem-climate feedbacks

Objectives

Apply observations, models, multiple tracers from ARM facilities to:

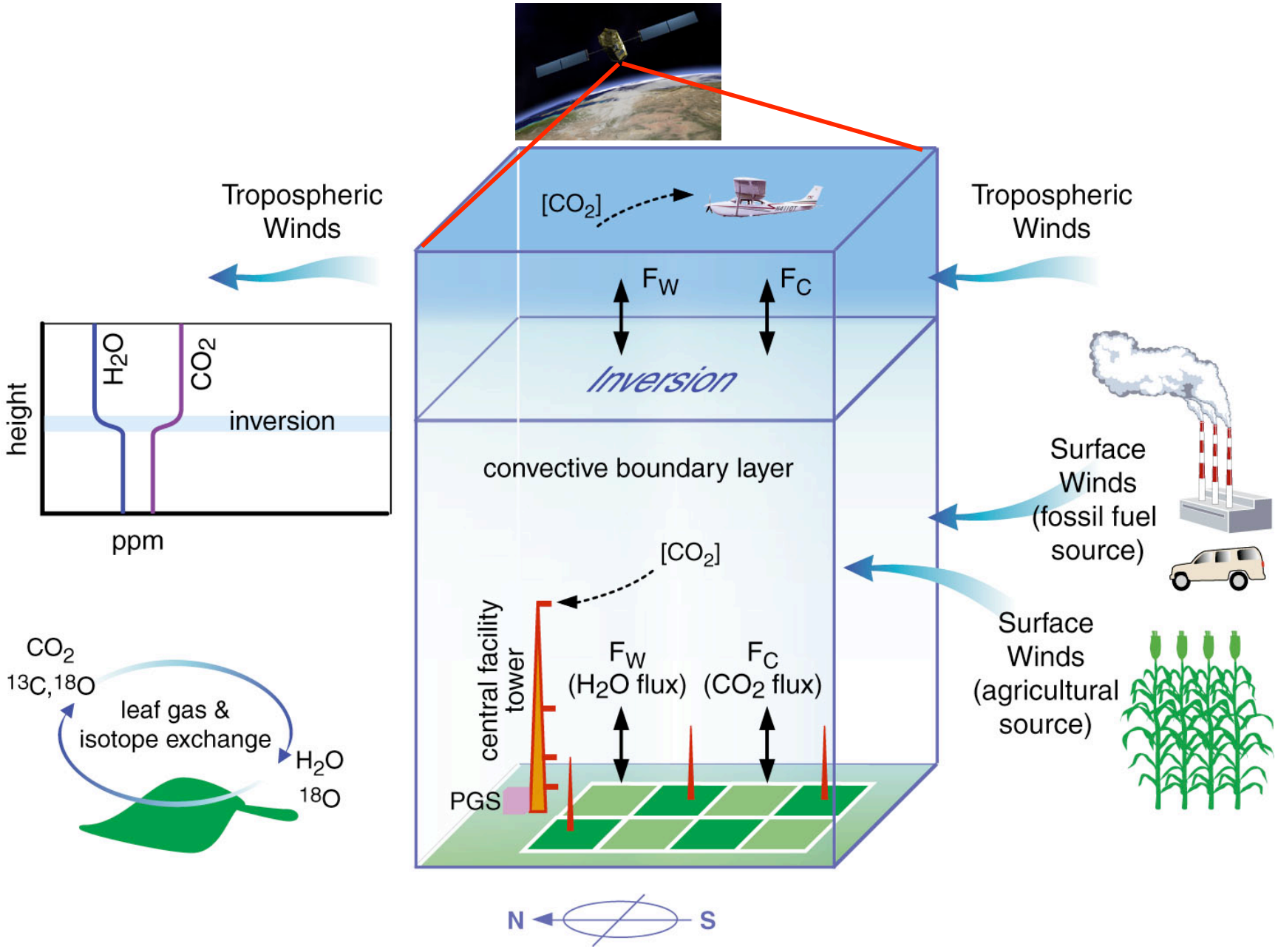
Quantify CO_2 sources, sinks, and concentrations in continental SGP

Measure and model land surface-atmosphere interactions and coupled C and water cycling

Support C4 models by providing parameters and data for testing

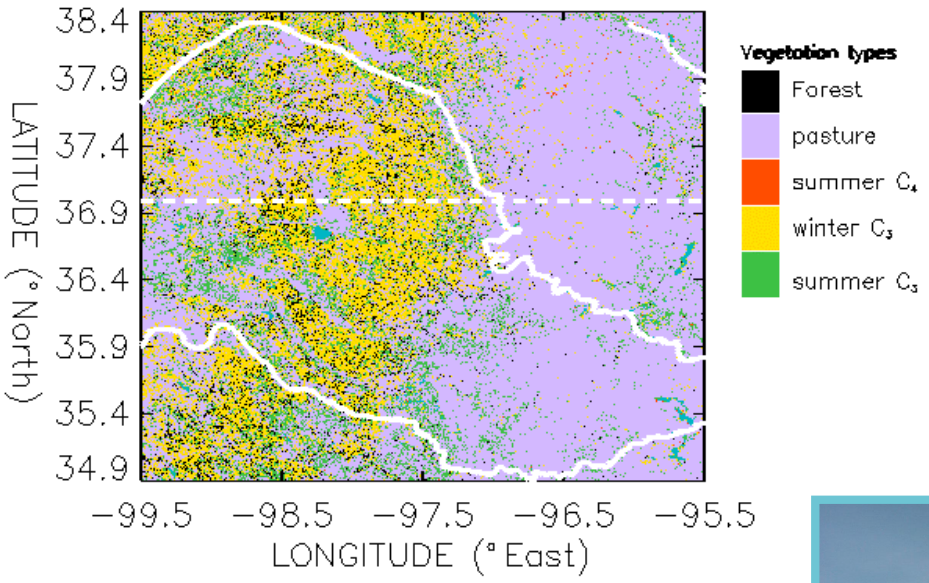
Improve prediction of CO_2 effects on radiation and temperature

Coupled Land-surface and Atmospheric Processes

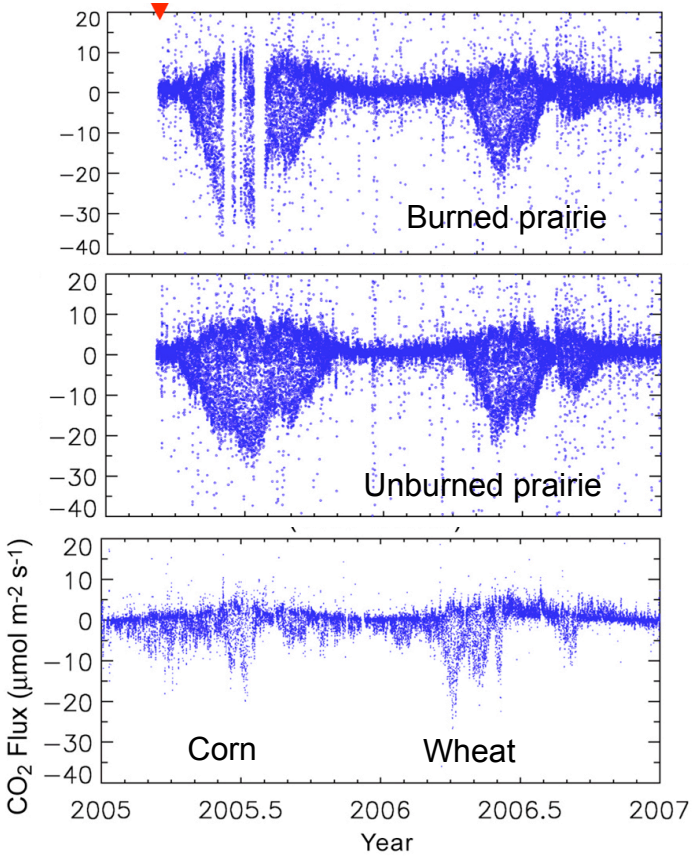


Patterns of Ecosystem Exchange

Heterogeneous Land Cover

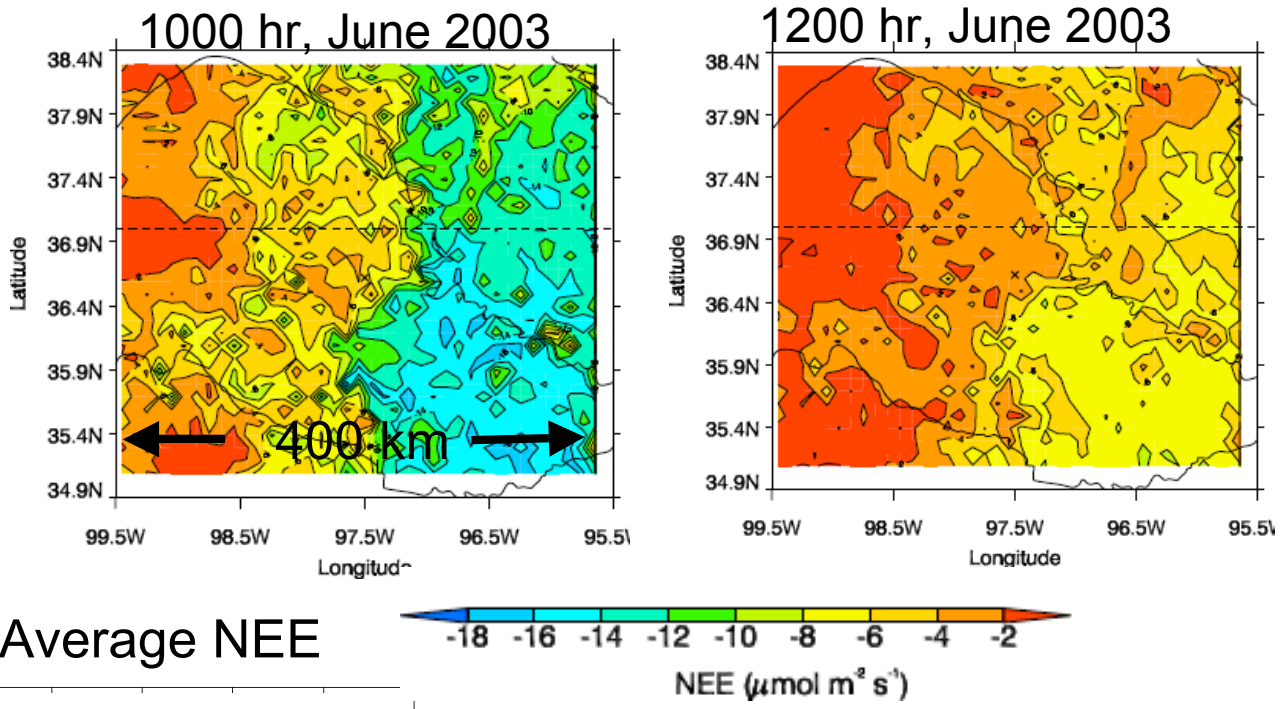


Heterogeneous CO_2 Flux

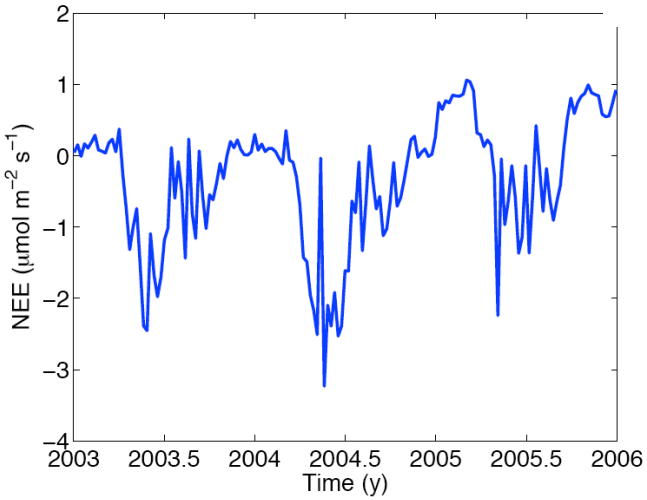


Eddy Covariance
Permanent at 4, 25, 60 m
Portable (two) at 4 m

Modeling Spatiotemporal Variations in NEE



Area Average NEE

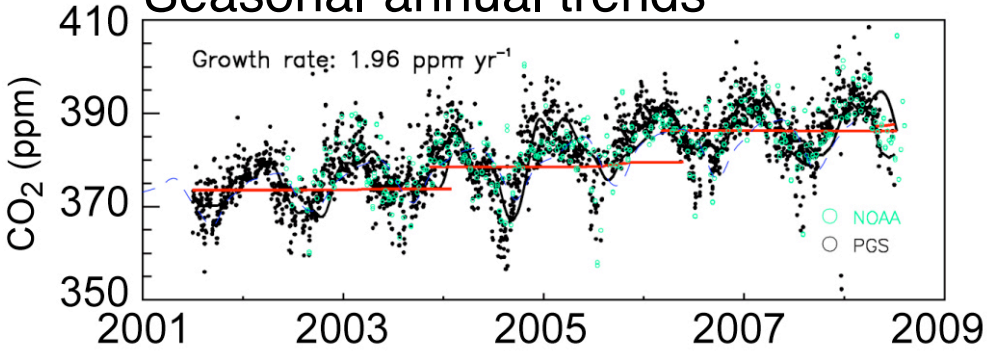


Net ecosystem CO_2 fluxes vary strongly across the ACRF-SGP

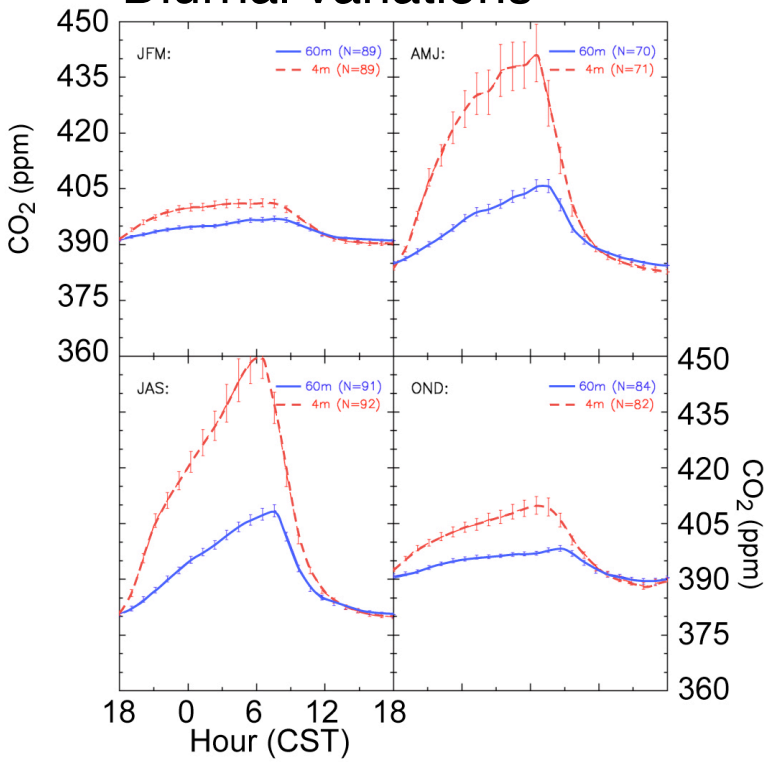
Trends in PBL CO_2

60 m tower at Central Facility and aircraft.
Continuous, precise CO_2, CO, and radon.
Flasks for ^{13}C,^{14}C, and NOAA (CH4, N2O, SF6, …)

Seasonal-annual trends



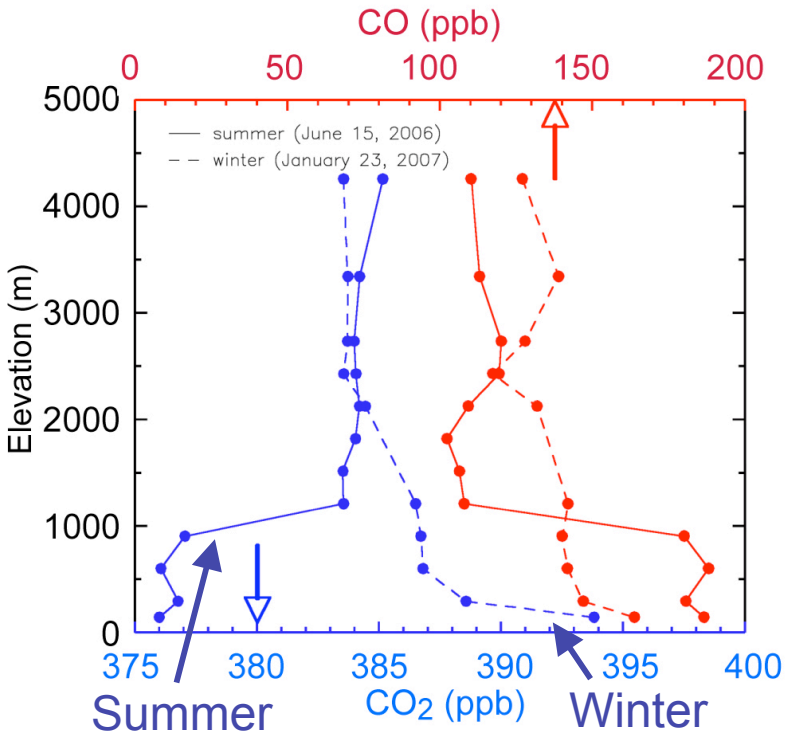
Diurnal variations

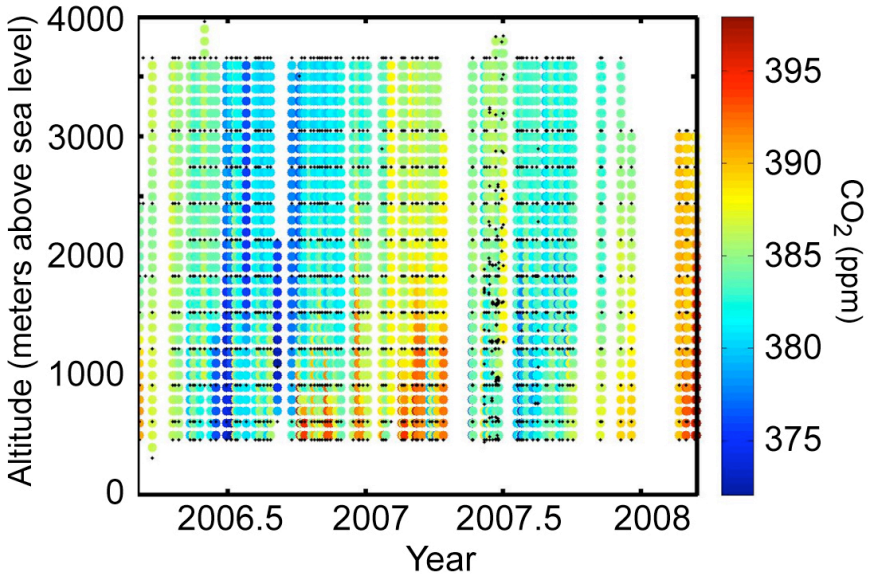


Vertical Structure of CO_2 & CO

Weekly Cessna flights (AVP)

- 2006-present: NOAA flasks (CO_2, CO, CH4, N2O, SF6, $^{13}CO_2$, Halocarbon, VOC)
- 2007-present: periodic ^{14}C flasks
- 2007-present: periodic continuous CO_2





Objectives for ARM Carbon research for OCO

Measure column CO_2 (χ_{CO2}) and compare with FTS and OCO retrievals

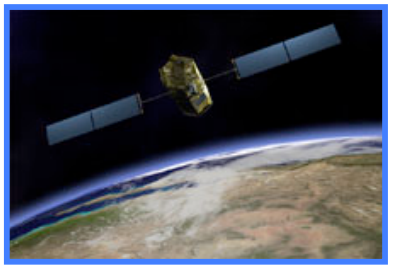
Apply *in situ* ground-based CO_2 measurements and ARM-AVP CO_2 profiles to determine χ_{CO2}

Estimate spatial variations in χ_{CO2} not sampled by OCO

Apply predictions of χ_{CO2} from coupled land-surface atmosphere model

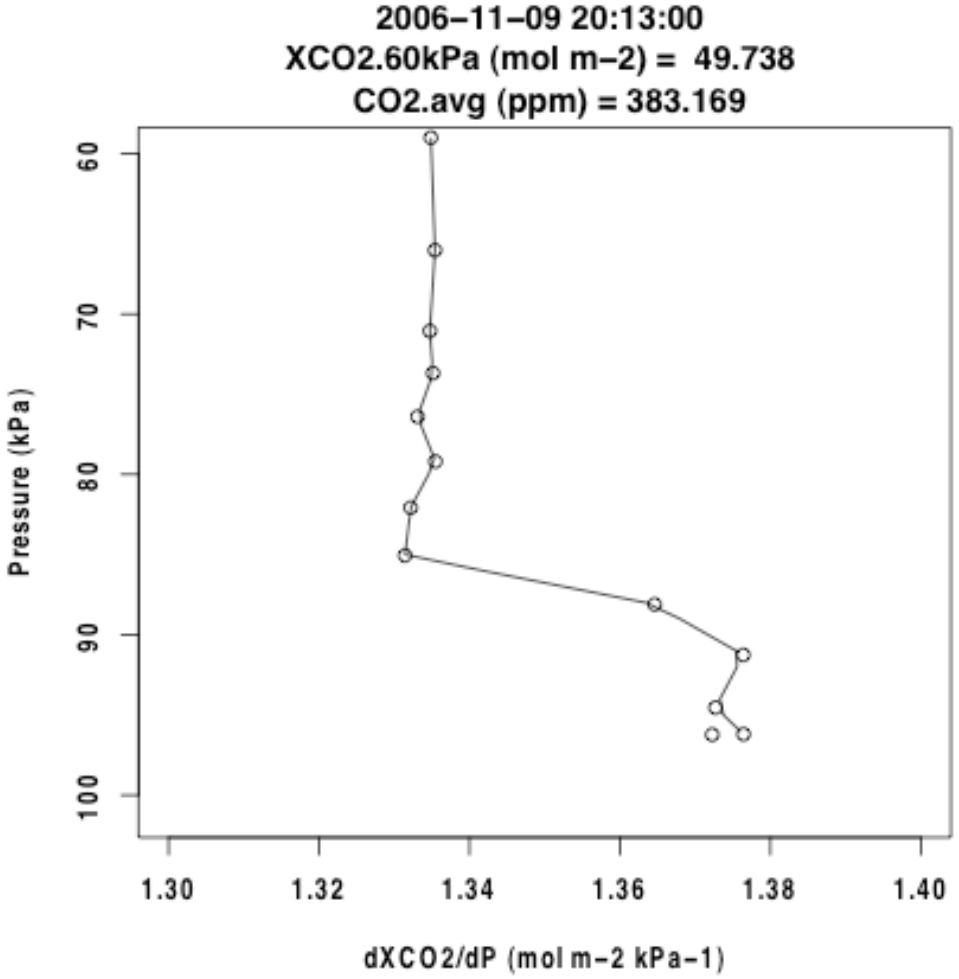
Estimate cloud and aerosol bias in χ_{CO2}

Apply ARM surface and remote sensing assets to OCO and FTS retrieval residuals



Initial Estimate of Column CO_2

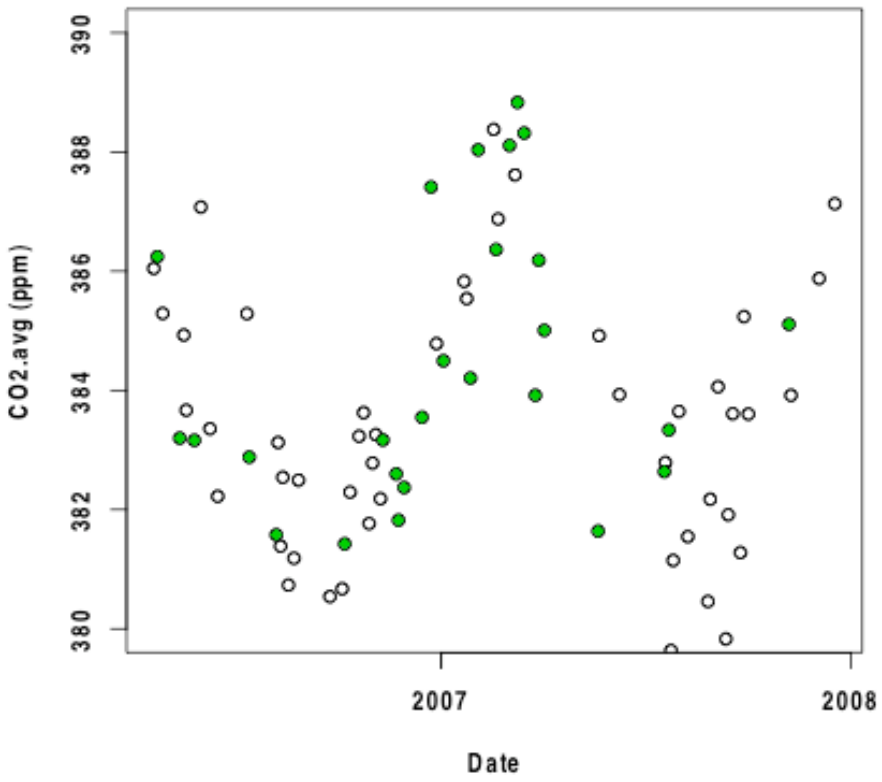
- Example CO_2 profile
  - Combines tower and aircraft measurements (CO_2, P, T, RH)
  - Max altitude 60kPa
    (~ 0.4 of total column)
  - Fall season column-average CO_2 ~ 10 ppm lower than 60m CO_2 (394 ppm)
  - Spring season shows opposite gradients



Time series of 60kPa column average CO_2

- Current data set includes ~ 100 profiles
  - Fewer afternoon (green) measurements
- Amplitude of seasonal cycle ~ 6 ppm
- Error analysis in progress
- 2008 data available soon
  - Many flights only reached 70 kPa
  - New contract will provide flights to ~ 50 kPa

Partial-column average CO_2



Further Work

- Complete processing of 2008 data
  - Analysis of pressure and water vapor errors
  - Comparison of measured profiles with FTS algorithm
  - Comparison of FTS retrieval with in-situ column estimate
- Identification and integration of additional ARM data for data classification
  - Cloud cover, aerosol depth
- Modeling investigation of expected spatial variability in column CO_2